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ABSTRACT

A total of 163 microcomputer programs evaluated by the Educational Products Information Exchange (EPIE) Institute through December 1983 were examined in order to identify strengths and weaknesses in instructional and technical design. Programs were evaluated in a variety of areas including the arts, business education, computer languages, computer literacy, early childhood, language arts, logic/problem solving, mathematics, reading, science, and social studies. Courseware types included drill and practice, educational game, tutorial, and simulation. It was found that most of the courseware did not utilize microcomputer features effectively. There was an overwhelming lack of field testing evidence in the course of program development. A large portion of the courseware included no support materials, unclear or developmentally inappropriate learner objectives, and few, if any, instructional suggestions or information to aid in integrating a program into the curriculum. Audio, when included, tended to be distracting. More than half of the courseware examined failed to use an approach which lent itself to an effective delivery. There was little evaluation of student learning and few programs included a management system. Strengths were, however, found in several areas: most programs were accurate in that there were few errors of fact, spelling, or grammar; little controversial content and few instances of stereotyping were noted; there were good warranties on courseware; and there was some effective use of graphics. Courseware development recommendations, a four-item bibliography, and a list of characteristics and criteria used in ranking courseware are included. (Author/ESR)

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Microcomputer Courseware: Characteristics and Design Trends

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Abstract

One hundred sixty three microcomputer courseware programs evaluated by the Educational Products Information Exchange (EPIE) Institute across several areas, including: the arts, business education, computer languages, computer literacy, early childhood, language arts, logic/problem solving, mathematics, reading, science and social studies,were examined in order to identify both strengths and weaknesses in instructional and technical design. Courseware types included drill and practice, educational game, tutorial and simulation.

Findings indicate weaknesses in several areas. There was an overwhelming lack of field testing evidence in the course of program development. A large portion of the courseware included no support materials, unclear or developmentally inappropriate learner objectives, and few, if any, instructional suggestions or information to aid in integrating a program into the curriculum. Audio, when included, tended to be distracting. More than half of the courseware examined failed to use an approach which lent itself to an effective delivery. There was little evaluation of student learning and few programs included a management system.

Strengths were also evident in several areas. Most programs were accurate in that there were few, if any, errors of fact, spelling, or grammar. Little controversial content, and few instances of stereotyping were noted. In general, there were good warranties on courseware. Graphics were used most effectively in early childhood, logic/problem solving and mathematics courseware.

In addition, trends within five specific areas--early childhood, language arts, logic/problem solving, mathematics and reading--were examined and recommendations made as to the direction in which courseware development might proceed in order to make greater use of the capabilities of the microcomputer.

Microcomputer Courseware: Characteristics and Design Trends

The use of microcomputers in schools and homes has expanded at a phenomenal rate. The National Center for Educational Statistics reports a growth from approximately 31,000 microcomputers in the schools in Fall, 1980 to nearly 300,000 at the end of 1983 (Bell, 1984).

Along with this growth in computer use there has been an increase in the need for high quality courseware (educational software). The Technology Assisted Learning Market Information Service (TALMIS), predicted that "software expenditures will grow from 15 percent of a district's computer budget in 1983... to almost 75 percent by 1988" ("Surge in School Software," 1984). This increase will result in $312 million being spent on courseware four years from now.

The Educational Software Selector (TESS), which lists all educational software available through commercial channels as of December, 1983 includes over 4,500 educational programs in 24 areas. Of the 24 areas examined, mathematics had the largest number of programs (26.3%). Other areas with a large number of programs were science (15.7%), reading (11.8%), language arts (10.6%) and social studies (6.2%). For a complete breakdown of all areas see Table 1.

Insert Table 1 about here

Most of programs listed in TESS were of the drill and practice type (49.4%). The second largest courseware type was tutorial with 18.9%, followed

by educational game (12.3%) and simulation (5.4%). For a complete breakdown of courseware by types see Table 2.

Insert Table 2 about here

According to a Johns Hopkins University survey (October 1983) elementary schools use drill and practice programs more often than any other type of courseware (22%). Approximately 40% of all instructional time on microcomputers in elementary schools is spent using courseware to practice mathematics, language facts, spelling and various other memorization tasks. Thirty-five percent of instructional time is spent having students copy, write and test computer programs. The remaining 25% is occupied playing games under the direction or approval of a teacher (Johns Hopkins University, June 1983).

In secondary schools, programming and computer literacy activities occupy two-thirds of the time spent on computers. Drill and practice courseware is used 18% of the time. The remainder is split among educational games and other applications such as word processing and business courses (Johns Hopkins University, June 1983).

Unfortunately, the development of commercially available courseware lags far behind that of hardware. Those involved in commercial courseware development, primarily publishing houses and computer manufacturers oftentimes lack expertise with regard to the instructional issues involved in designing educationally sound courseware. In addition, their experience in using a highly interactive medium such as the microcomputer is fairly limited. It is not uncommon for the emphasis to be placed on producing a marketable product as rapidly and simply as possible. Consequently, much

of the courseware currently being developed is poorly designed and does not take advantage of the potential or capabilities of the microcomputer. Nevertheless, schools that have money to spend on courseware are forced to purchase products that are often of questionable value. They are then faced with the task of integrating this courseware into their curricula.

This study examines a variety of microcomputer courseware products commercially available in order to identify both strengths and weaknesses. Recommendations are made as to the direction in which courseware development might proceed in order to make greater use of the capabilities of the microcomputer and to better meet the educational needs of schools.

Methods

All microcomputer courseware evaluations completed by the EPIE Institute through December, 1983 were analyzed. This included 163 evaluations: 139 single disk, limited content programs and 24 multiple disk, extensive content programs. Programs were evaluated in a variety of areas including the arts, business education, computer languages, computer literacy, early childhood, language arts, logic/problem solving, mathematics, reading, science and social studies. The number of evaluations by subject area and courseware type was compiled. Courseware types included drill and practice, educational game, tutorial and simulation.

Using the EPIE framework for evaluating any instructional material, four main areas were examined: intents, content, methods and approach, and evaluation. Within each of these areas, several characteristics were examined. Intents included: development evidence, learner objectives and goal/content match. Content included: user appropriateness, accuracy and fairness, clarity and support materials. Characteristics examined within the area of

methods and approach included: technical quality, warranty, technical documentation, instructional documentation, user control, feedback, graphics, audio, random generation and the extent to which the approach enhanced presentation of the content. The fourth area, evaluation, included: tests, branching, records, management and the extent to which the program's effectiveness was evaluated. Criteria were developed so that each program could be rated for each characteristic in order to determine areas of strength and weakness. For a complete description of these characteristics and criteria for ranking see Appendix.

Percentages were computed to determine if trends existed across areas and courseware types. In addition, trends within five specific areas were examined: early childhood, language arts, logic/problem solving, mathematics and reading.

Results

Of the eleven areas examined, mathematics had the highest number of programs evaluated (47). Of these programs, 38 were single disk and 9 were multiple disk. Other areas with a large number of programs evaluated were: language arts with 38 (32 single disk, 6 multiple disk), reading with 24 (20 single disk, 4 multiple disk), early childhood with 16 (all single disk) and logic/ problem solving with 15 (all single disk). Table 3 shows the complete breakdown of all areas examined.

Insert Table 3 about here

Of the four courseware types examined, drill and practice, educational game, tutorial and simulation, the overwhelming majority fell into the drill

and practice category (69.9%). Two-thirds of these were only drill and practice; the remaining one-third used either a game format or contained a tutorial component. The second largest courseware type was educational game with 14.1%, followed by tutorial and simulation, each with 6.8%. Table 4 summarizes these results.

Insert Table 4 about here

Several trends emerged when data were analyzed by characteristic for all courseware. In addition, trends specific to the five areas examined in depth--early childhood, language arts, logic/problem solving, mathematics and reading--were also found.

Development Evidence

There was an overwhelming lack of field testing evidence in the course of program development for all courseware. Approximately 80.4% of the programs had no development evidence.

Learner Objectives

Only one-third of the programs had well defined, educationally appropriate objectives. More than one-half had either no objectives stated, or unclear, developmentally inappropriate ones. Eighty percent of the courseware in logic/problem solving was weak in this area.

Goal/Content Match

Findings in this area were quite mixed, with one outstanding result. More than 50% of all mathematics courseware had goals and objectives that were well supported by the content. Multiple disk mathematics programs made an even better showing with 66.7% having well supported goals and objectives.

User Appropriateness

Findings with respect to the appropriateness of materials for intended users were mixed.

Accuracy and Fairness

Most programs (81.6%) were accurate in that there were few, if any, errors of fact, spelling or language usage. Little controversial content and few instances of sex, race or ethnic stereotyping were noted.

Clarity

Clarity of presentation as demonstrated in directions, frame formatting and content expression was mixed across courseware. In the area of reading, results indicated that most of the reading courseware (55%) did not meet even minimal expectations.

Support Materials

A large portion (68.8%) of the courseware examined included no support materials of any kind. When support materials were provided, they were not generally useful or appropriate.

Technical Quality

Most of the programs (87.1%) evaluated were easy to load and use and were free of programming errors.

Warranty

Fifteen percent of the programs had no warranty. When warranties were included they were typically 30 to 90 day replacement.

Technical Documentation

Findings regarding operating instructions were mixed with one exception. Technical documentation for reading programs was clearer and more complete than it was in any other area.

Instructional Documentation

Instructional suggestions or information to aid in integrating a program into the curriculum were absent or inadequate in 62% of the programs.

User Control

The inclusion of menus and options to exit, review instructions, call for help, alter the rate of presentation, etc. were present as often as not. Reading courseware, however, provided less user control than any other area.

Feedback

In most cases, feedback was immediate and included some form of reinforcement (68.8%). In only 16.1% of the programs was there any remediation.

Graphics

While the use of graphics varied, programs in some areas tended to make better use of them. In almost one-half of the early childhood, logic/problem solving and mathematics programs, graphics were more likely to be embedded in content as well as feedback, and to be clear, innovative and appropriate.

Audio

Audio was not used in more than one-quarter of the programs evaluated. When it was used, 55.5% of the time it could not be turned off and was likely to be distracting. This was also true for 92.3% of the early childhood programs.

Random Generation

In general, courseware tended to make little use of random generation. It was used in content and activities, only 39.9% of the time.

Approach Enhances Content

More than half of the courseware examined failed to use an approach that lent itself to an effective delivery or appealing presentation that clarified

or enhanced content. This was especially true for reading (70%) and language arts (63.2%) courseware.

Tests

Seventy-eight percent of the courseware examined included no tests of any kind. That is, only 36 out of the 163 programs examined included tests.

Branching

Almost three-fourths of the courseware did not make use of branching for presentation of either content or feedback. Mathematics programs, however, made better use of branching than any other area. When branching was incorporated, it was likely to be used for both content and feedback.

Records

Data on recordkeeping were varied across areas with the exception of early childhood programs, where 75% did not include any form of recordkeeping.

Management

Overwhelmingly, the programs examined had no management systems (78.9%). Out of the total sample, only 34 programs included a management system. Programs developed for early childhood (93.8%) and logic/problem solving (93.3%) were least likely to include this feature.

Evaluation

There was little evaluation of student learning provided. Approximately 61.1% of the programs examined had no form of evaluation. Only 5 programs--all in mathematics--adequately measured mastery of objectives. Multiple disk programs were more likely to include some type of evaluation than single disk programs.

Discussion

As the data show, most of the courseware currently available does not utilize microcomputers effectively. Much of this courseware is poorly designed instructionally and is no more than electronic workbooks.

Clearly stated learner objectives, means of evaluating the effectiveness of these programs and instructional documentation that facilitates their use as an integral part of the curriculum must be provided. If microcomputers are to be valuable instructional tools, courseware must be developed which is based upon sound instructional design techniques that incorporate the capabilities of the microcomputer. These include the ability to:

*customize instruction to meet the needs of individual learners by using branching and feedback that remediates based upon specific errors.

*create an interactive environment in which the learner is given opportunities to control various aspects of his or her work. For example, options to review content at any time and to select the difficulty level of material to be presented.

*motivate the learner through the use of interesting and informative graphics and audio which are embedded in the content.

*track learner performance by storing records on disk. Management systems, in addition to tracking performance, allow teachers to structure and sequence learning.

Unlike the textbook industry, unfortunately, the microcomputer software industry is not dependent upon educational institutions for survival. Therefore, educators must take a very proactive role and demand quality courseware from producers. Courseware producers must consult subject

matter, learning specialists and instructional designers when developing materials. Formative evaluation, including field testing with students, must be an integral part of the development process. It is time for educators to make a choice regarding the kind of courseware they want to use in their schools and classrooms and not allow producers, by default, to make this choice for them.

References

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Table 1

Percent of Programs Listed in TESS by Area

Area	%
Mathematics	26.3
Science	15.7
Reading	11.8
Language Arts	10.6
Social Studies	6.2
Foreign Language	4.6
Computer Language	2.4
The Arts	2.2
Early Childhood	2.2
Business Education	1.9
Logic/Problem Solving	1.1
Computer Literacy	0.9
Other (Physical Education, Health, Home Economics, etc.)	14.1
	100.0

Table 2

Percent of Programs Listed in TESS
by Software Type

Software Type	%
Drill and Practice	49.4
Tutorial	18.9
Educational Game	12.3
Simulation	5.4
Other	14.0
	100.0

Table 3

Percent and Number of Courseware Evaluations by Area

Area	%	n	Single disk	Multiple disk
Mathematics	28.8	47	38	9
Language Arts	23.3	38	32	6
Reading	14.8	24	20	4
Early Childhood	9.8	16	16	0
Logic/Problem Solving	9.2	15	15	0
Social Studies	4.9	8	6	2
Business Education	3.1	5	5	0
Science	3.1	5	3	2
The Arts	1.2	2	2	0
Computer Literacy	1.2	2	1	1
Computer Languages	0.6	1	1	0
	100.0	163	139	24

Table 4

Percent and Number of Courseware Evaluations By Courseware Type

Courseware Type	%	n
Drill and Practice	69.9	114
Educational Game	14.1	23
Tutorial	6.8	11
Simulation	6.8	11
Other	2.4	4
	100.0	163

APPENDIX

Characteristics and Criteria for Ranking

Intents

Development Evidence

- Strong - actual evidence presented in package and reviewed as adequate
- Mixed - testing and results that are only partially adequate
- Weak - statements of testing without any evidence or explanation of procedures or results
- None

Learner Objectives

- Strong - both general and specific objectives stated; clarity and completeness; educationally and developmentally appropriate; statements as to how objectives will be carried out and/or examples; objectives stated by level when appropriate
- Mixed - partially adequate with respect to above named issues
- Weak - inferred objectives; lacking clarity and/or completeness; not educationally or developmentally appropriate; no indication of how objectives will be met

Goal/Content Match

- Strong - goals and objectives supported by content
- Mixed - goals and objectives somewhat supported by content
- Weak - goals and objectives not supported by content

Content

User Appropriateness

- Strong - target audience specified; age appropriate with respect to skills required
- Mixed - inferred target audience with age appropriate content/skill match
- Weak - not age appropriate; no target audience

Accuracy and Fairness

- Strong - no errors of factual presentation, grammar or spelling; no controversial content or social baises
- Mixed - minimal errors of fact, grammar or spelling; no errors of fact, grammar or spelling -- but social bias; no social bias -- but errors of fact, grammar or spelling (if minimal)
- Weak - numerous errors of fact, grammar or spelling; controversial content or social bias

Clarity

Strong - clear presentation both with respect to the visual presentation and the content expression especially with regard to directions; frame formatting that is helpful; not ambiguous in expectations
Mixed - partial fulfillment of above named criteria, however, clarity of presentation must be adequate
Weak - lacking above named criteria

Support Materials

Strong - extent of materials provided and appropriateness for target audience; usefulness
Mixed - partially fulfilling above named expectations
Weak - not fulfilling above named expectations
None

Methods and Approach

Technical Quality

Strong - no programming errors; easy to load; easy to use
Mixed - minor errors that do not markedly distort content presentation
Weak - technical errors that prevent efficient content delivery; difficult to use for target audience

Warranty

Strong - warranty provided
None

Technical Documentation

Strong - clear, complete operating instructions
Mixed - partial fulfillment of above named criteria
Weak - lacking above named criteria
None

Instructional Documentation

Strong - extent of instructional suggestions; suggestions that address integration into curriculum
Mixed - partial fulfillment of above named criteria
Weak - lacking above named criteria
None

User Control

Strong - menu included; user can: exit, review instructions, call help, alter rate of presentation, etc.
Mixed - menu; exit, and review
Weak - menu only

Feedback

Strong - immediate; reinforcement; remediation
Mixed - immediate with reinforcement; no remediation
Weak - immediate but no reinforcement; no remediation

Graphics

Strong - embedded in content as well as feedback; clear; innovative; appropriate
Mixed - partial fulfillment of above named criteria
Weak - lacking above named criteria
None

Audio

Strong - can be turned off; embedded in content and not distracting; not irritating
Mixed - does not enhance content; can be turned off
Weak - distracting; cannot be turned off
None

Random Generation

Strong - used for content presentation as well as feedback
Mixed - used for content only
Weak - used for feedback only
None

Approach Enhances Content

Strong - effective delivery; appealing presentation; clarifies content
Mixed - boring but may help
Weak - ineffective delivery; confuses rather than clarifies

Evaluation

Tests

Strong - full range of pre, post, and mastery tests that are adequate with regard to age, educational intent, and developmental expectations
Mixed - partial fulfillment of above named criteria
Weak - lacking above named criteria
None

Branching

Strong - used for both content and feedback presentations
Mixed - branching takes user back to previously seen material
Weak - branching is optional; not helpful
None

Records

Strong - percent correct reported; nature of errors outlined; percent of correct responses reported; information can be saved on disk
Mixed - percent of correct response reported; not stored
Weak - print materials provided for recordkeeping

Management

Strong - easy to use; well structured; useful
Mixed - partial fulfillment of above criteria
Weak - lacking above named criteria
None

Evaluates Effectiveness

Strong - mastery of objectives adequately measured
Mixed - limited measurement of mastery of objectives
Weak - mastery of objectives inadequately measured
None